PHOTOGRAPH THIS SHEET

AD-A954 820

DTIC ACCESSION NUMBER

LEVEL

INVENTORY

WAL 710/788

DOCUMENT IDENTIFICATION

29 NOV 1945

This document has been approved for public release and sale; its distribution is unlimited.

DISTRIBUTION STATEMENT

ACCESSION FOR		
NTIS	GRA&I	☒
DTIC	TAB	☐
UNANNOUNCED		☐
JUSTIFICATION	per ltr	
BY		
DISTRIBUTION /		
AVAILABILITY CODES		
DIST	AVAIL AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

UNANNOUNCED

DTIC ELECTE AUG 1 2 1985 S E D

DATE ACCESSIONED

DATE RETURNED

85 8 08 076

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NO.

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDAC

DTIC FORM 70A DEC 83

DOCUMENT PROCESSING SHEET

PREVIOUS EDITION MAY BE USED UNTIL STOCK IS EXHAUSTED.

Copy No. 2

WATERTOWN ARSENAL LABORATORY

MEMORANDUM REPORT

NO. WAL 710/788

Comparative Resistance of Various Components of Experimental Helmet T21E1

BY

J. F. Sullivan
Assoc. Ord. Engineer

DATE 29 November 1945

WATERTOWN ARSENAL
WATERTOWN, MASS.

Form No. SPOBE-38
L 18 July 1944

00400.112/8681 7 Jan. 46

Distribution:

1 c. SPOTX-AP

5 c. SPOTS

2 c. to be returned

~~RESTRICTED~~ CONFIDENTIAL UNCLASSIFIED

WATERTOWN ARSENAL LABORATORY

MEMORANDUM REPORT NO. WAL 710/788

Partial Report on Problem B-7.16

29 November 1945

Comparative Resistance of Various Components of Experimental Helmet T21E1

1. At the request of the Office, Chief of Ordnance[1], ballistic tests have recently been conducted at this laboratory on various components of the experimental helmet, T21E1.

2. On the basis of these tests a three-ply nylon inner component is to be preferred over a three-ply fiberglas inner component, and a 24ST duralumin outer component (of average gauge = .109") is to be preferred over a 75ST duralumin outer component (of average gauge = .097"). However, while the superiority of the nylon component over the fiberglas component appears to be independent of weight (although perhaps a result of thickness), the superiority of the 24ST component over the 75ST component seems directly attributable to the weight (thickness) difference. Thus, as regards resistance to cal. .22 fragment simulating projectiles[2], equivalent weights (thicknesses) of 24ST and 75ST duralumin could be expected to perform equivalently, whereas equivalent weights of the nylon and fiberglas laminated components have demonstrated the superiority of the nylon laminate.

3. Grids of one-inch squares, four squares wide, were laid out, from front to rear, and from side to side, on each metallic component. Thickness measurements were read for each square and are shown in Figure 1. Representative locations on each of the non-metallic components were measured for thickness and these results are recited in Table I.

4. Before each round was fired the target component was erected in such a manner as to provide that the surface to be impacted was tangent at the point of anticipated impact to a plane perpendicular to the expected flight of the projectile. Velocities were measured by means of a Remington Arms Company chronoscope with photo-electric cell pickup and a time delay input unit. Each component was subjected to a number of impacts with cal. .22 fragment-simulating projectiles, T37, sufficient to establish its

---

1. O.O. 421/321(c) - Wtn. 421/533(c), 26 September 1945.
2. WAL 762/253

UNCLASSIFIED

apparent ballistic limit (P). The results of the tests on the metallic components appear in Figures 2 and 3. The results of tests on the non-metallic components appear in Table II.

5. It is thus apparent that the resistance of the nylon component (apparent ballistic limit about 800 feet-per-second) is to be preferred over that of the fiberglas component (apparent ballistic limit about 600 feet-per-second). Even though the nylon component is thicker (.057" versus .045") than the fiberglas component in about the same ratio as their ballistic limits, and perhaps the superiority of the nylon component may be attributed to this greater thickness, the fact that the weights per unit area are equivalent demands the preference of the nylon constituent.

6. On the other hand, although the 24ST component with an average ballistic limit of 815 feet-per-second is superior to the 75ST component with an average ballistic limit of 760 feet-per-second, the superiority is not demonstrated at an equivalent weight and extrapolation indicates that if equivalent weights were tested equivalent ballistic limits would result. Therefore, 24ST and 75ST duralumin may be considered interchangeable as outer components without prejudice to the ballistic integrity of a helmet assembly.

7. As would be expected from the foregoing, the combination of the 24ST duralumin component with the nylon laminate component represented the best team among the four available component combinations. This combination represented a distinct improvement of the current M1 combination of Hadfield manganese steel shell with plastic liner of dubious ballistic merit, although the overall weights are equivalent.

8. It is thus concluded that an experimental helmet, T21E1, with a three-ply nylon laminate inner component and an outer component of either 24ST or 75ST duralumin will provide:

a. Improved resistance to fragment attack over the current M1 helmet assembly if the overall weights are held constant;

b. A saving in overall weight, as compared with the current M1 helmet assembly, if the protection is held constant; or

c. A combined saving in weight and increased protection, as compared with the current M1 helmet assembly, if a weight intermediate between the current weight and one which would provide current protection is chosen.

J. F. Sullivan

J. F. Sullivan
Assoc. Grd. Engineer

APPROVED BY:

E. L. Reed

E. L. REED
Research Metallurgist
Chief, Armor Section

TABLE I

Thickness Measurements on Inner (Non-Metallic) Components of Experimental Helmet T21E1

Material	Gauge at Rim	Front	Top	Back	Left	Right
Nylon	.060"	.057"	.050"	.057"	.058"	.061"
Nylon	.075"	.054"	.053"	.057"	.057"	.062"
Fiberglas	.047"	.040"	.040"	.042"	.044"	.042"
Fiberglas	.045"	.049"	.044"	.050"	.045"	.048"

Average thickness of nylon components - .057"

Average thickness of fiberglas components - .045"

TABLE II

Summary of Ballistic Tests Conducted Against Various Proposed Components of Experimental Helmet T21E1

Material	Ave. Gauge	Ballistic Limit (P) (Cal. .22, T37)
24ST	.109"	815
75ST	.097"	760
3-Ply Nylon	.057"	800
3-Ply Fiberglas	.045"	600
24ST Plus 3-Ply Nylon	—	1320
24ST Plus 3-Ply Fiberglas	—	1247
75ST Plus 3-Ply Nylon	—	1231
75ST Plus 3-Ply Fiberglas	—	1163
Current M1 Helmet Assembly (.040")*	—	1040(A)

*WAL 710/738 - Protection limit probably 50 feet-per-seconds higher than Army limit.

24 ST HELMET

AVERAGE RECORDED THICKNESS .109"

REAR

						.117	.117	.120	.122						
						.118	.118	.120	.120						
						.119	.119	.118	.121						
						.106	.104	.103	.106						
						.099	.097	.097	.099						
.120	.111	.114	.113	.102	.100	.096	.099	.100	.100	.102	.107	.113	.119	.105	.122
—	.110	.115	.114	.101	.099	.095	.100	.101	.099	.099	.104	.110	.119	.106	—
.117	.103	.113	.113	.102	.100	.096	.096	.100	.098	.102	.102	.112	.120	.108	—
.120	.108	.115	.117	.103	.100	.097	.096	.099	.098	.100	.104	.112	.120	.109	.122
						.103	.102	.101	.103						
						.107	.106	.105	.106						
						.118	.117	.115	.115						
						.120	.120	.120	.120						
						.112	.113	.112	.113						
						.125	.126	.126	.126						

LEFT SIDE

RIGHT SIDE

FRONT VISOR

75 ST HELMET

AVERAGE RECORDED THICKNESS .097"

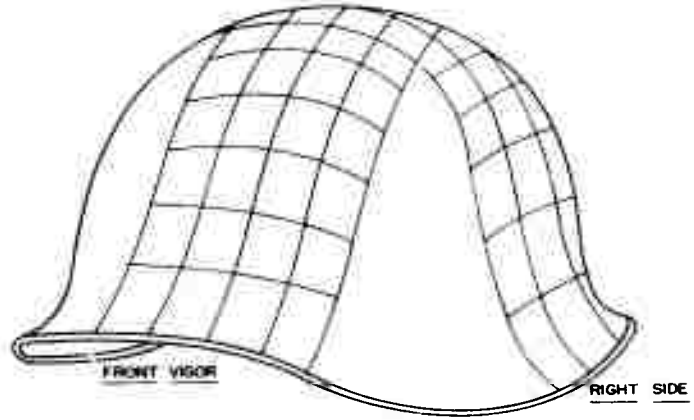
REAR

						.113	.113	.114	.113						
						.112	.112	.112	.112						
						.108	.110	.107	.110						
						.090	.090	.089	.091						
						.081	.081	.081	.081						
.107	.111	.116	.089	.083	.079	.081	.081	.080	.084	.091	.105	.113	.101	.114	
.104	.113	.104	.088	.083	.079	.082	.083	.081	.086	.092	.101	.111	.101	—	
—	.112	.104	.088	.083	.079	.079	.083	.081	.085	.092	.102	.110	.098	.112	
.104	.114	.105	.086	.083	.080	.080	.080	.080	.086	.092	.105	.110	.101	.112	
						.084	.082	.082	.084						
						.093	.090	.088	.089						
						.099	.097	.096	.096						
						.111	.109	.108	.109						
						.107	.110	.109	.104						
						.112	.115	.114	.115						

LEFT SIDE

RIGH SIDE

FRONT VISOR



LAYOUT OF LONGITUDINAL AND TRANSVERSE GRIDS FOR THICKNESS MEASUREMENTS

FIGURE 1

(GRID IS COMPOSED OF 1" SQUARES THICKNESS DETERMINED AT MIDDLE OF SQUARE)

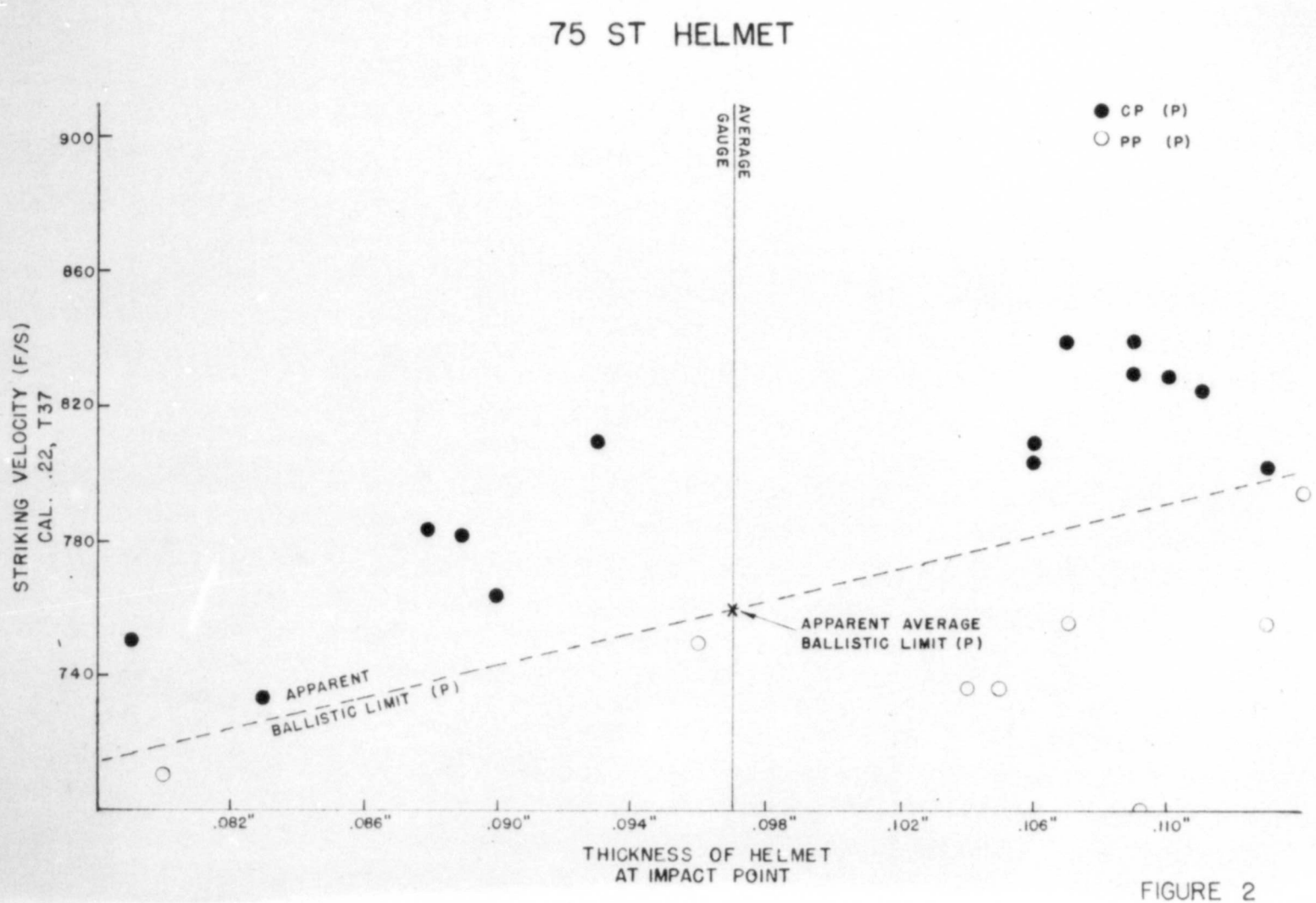

75 ST HELMET
CP (P)
PP (P)
AVERAGE GAUGE
900
860
820
780
740
STRIKING VELOCITY (F/S)
CAL. .22, T37
APPARENT BALLISTIC LIMIT (P)
APPARENT AVERAGE BALLISTIC LIMIT (P)
.082"
.086"
.090"
.094"
.098"
.102"
.106"
.110"
THICKNESS OF HELMET AT IMPACT POINT

FIGURE 2

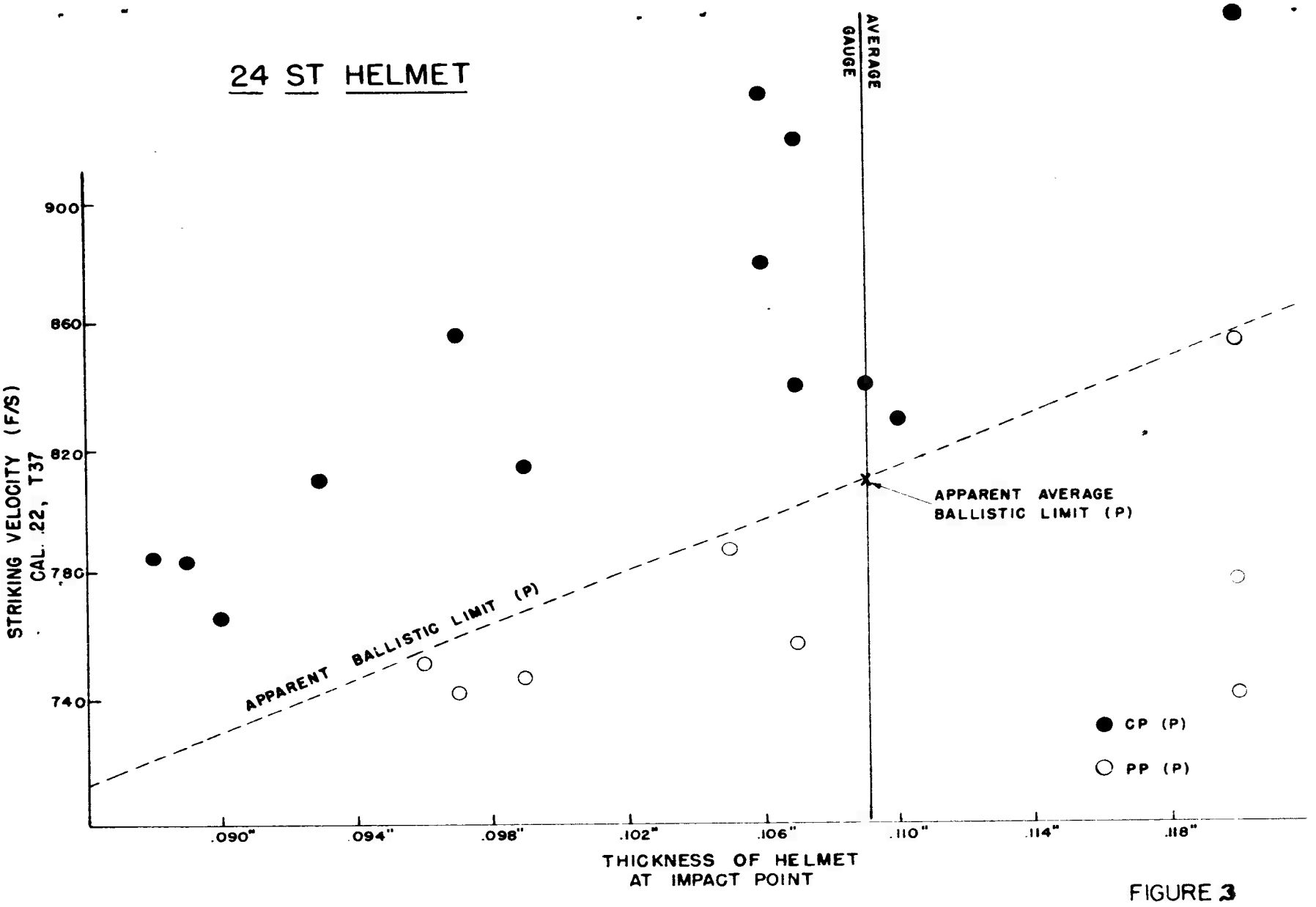

24 ST HELMET
AVERAGE GAUGE
900
860
820
780
740
STRIKING VELOCITY (F/S)
CAL. .22, T37
APPARENT BALLISTIC LIMIT (P)
APPARENT AVERAGE BALLISTIC LIMIT (P)
CP (P)
PP (P)
.090"
.094"
.098"
.102"
.106"
.110"
.114"
.118"
THICKNESS OF HELMET AT IMPACT POINT

FIGURE 3